HSTSS Quarterly

Newsletter of the _HARDENED SUBMINIATURE TELEMETRY and SENSOR SYSTEM_

The HSTSS Program

HSTSS is a program to develop subminiature G-hardened on-board instrumentation for small missiles, indirect fire projectiles and munitions, medium caliber and direct fire projectiles. **HSTSS** technologies and products are designed at die and chip-level for growth and expansion to support new applications and new requirements.

Annual HSTSS Symposium A Great Success

HSTSS hosted its annual symposium in Dallas, TX on 14, 15, and 16 September 1999. Despite the effects of hurricane Floyd on the East Coast of the US, there was a large turnout for the Symposium.

In all, over one hundred people attended, representing 45 different organizations: Government - 15 Commands, Industry – 27 Companies, and Academia – 3 Universities.

A CD-ROM of the symposium presentations is available. If you wish to receive a copy, please e-mail **Ed_Chester@stricom.army.mil** with your physical mailing address. The presentations are also temporarily available at the STRICOM FTP site: ftp://ftp.stricom.army.mil/pub/pmitts/HSTSS/Symposium/.

HSTSS Tri-Service Programs

Multiple Launch Rocket System (MLRS) - Prototypes are being completed and environmental testing is scheduled to commence in November, flight tests in December.

Tank Extended Range Munition - Kinetic Energy (TERM-KE) - Discussions were initiated with the TERM-KE project office and Alliant TechSystems on how **HSTSS** can benefit all parties by leveraging flight tests to include HSTSS instrumentation and antennae.

Test Flights – Successful Test flights of the **HSTSS** Multi-Chip Module and the FPGA PCM Data Encoder were conducted by **ARL** at **Yuma Proving Ground** in late August 1999.

Project Director's Notes

Special thanks to the people that attended and participated in the **HSTSS** Symposium. Your contributions made this event a great success. Thanks to your efforts, new relationships were forged and old relationships were rekindled. This is this kind of communication and cooperation that makes this endeavor successful.

HSTSS has a new logo. The star represents the STRICOM STAR Award that was bestowed upon the **HSTSS** Team. The star's points correspond to the **HSTSS** team members: US Army, US Air Force, US Navy, Industry, and Academia. The background colors represent the services' native environments: Army-green ground, Navy-blue water, Air Force-blue sky. The microchip in the upper field behind the star symbolizes **HSTSS** microelectronics. The crossed rocket and cannon represent platforms on which we test.

My phone number is **407-384-5236**, or **DSN 970-5236** and my e-mail is **Ronald_Colangelo@stricom.army.mil**. Please give me a call and let me know how we are doing or what we can do better.

Calendar of Upcoming Events

International Telemetry Conference (ITC)
25-28 October 1999
Riviera Hotel
Las Vegas, Nevada

Two half-day sessions are dedicated to HSTSS topics.

HSTSS Session:
Afternoon of Oct. 27 and Morning of Oct. 28

Flight Tests Conducted at YPG for *HSTSS* Electronic Packaging Rounds and FPGA PCM Encoder
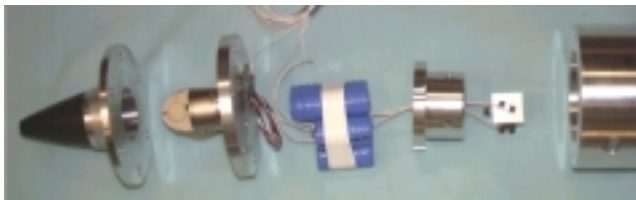
HSTSS MCM Electronic Packaging Flight Test

Electronic Packaging Test Round

Electronic Packaging Telemetry Assembly
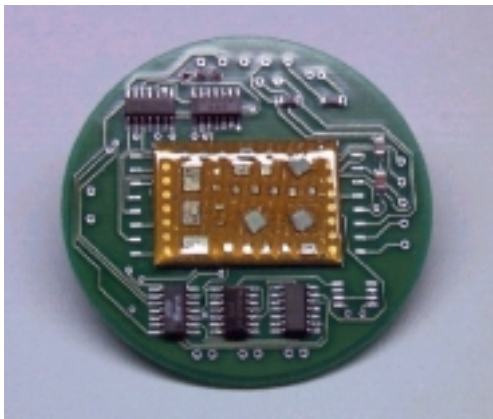

Three-Channel Recorder
Multi-Chip Module (MCM)

Two **HSTSS** instrumented "packaging" rounds were flight tested at **Yuma Proving Grounds AZ** in August. Both firings were 100% successful and valuable data were collected.

The **Army Research Lab (ARL)** integrated the instrumentation into two modified 120mm M831 type rounds. Each round contained a 3-channel digital recording system implemented on a programmable MCC Multi-Chip Module (MCM). The **Johns Hopkins University Applied Physics Lab** performed the die- level assembly. The instrumentation system was designed to measure in-bore balloting and set back accelerations. A MR spin sensor was also on-board to measure the in-flight spin history.
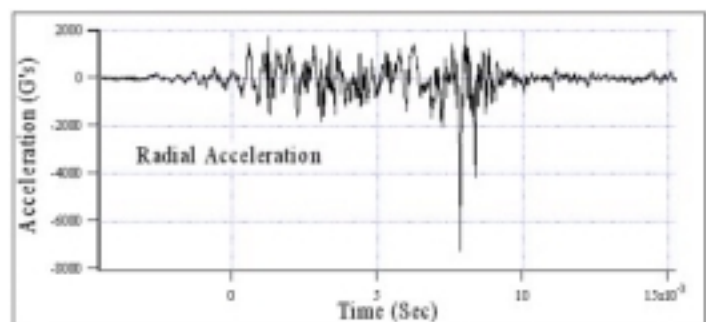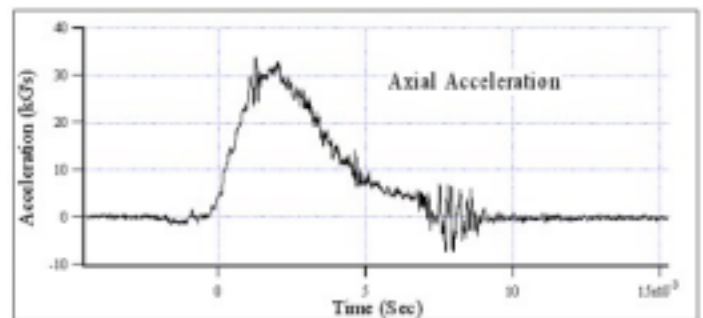
The flight test objectives were to qualify MCM technology for high-g applications, qualify/develop microelectronics packaging and assembly techniques, conduct "Proof-of-Concept" for **HSTSS** delay/repeater circuits, and make measurement of in-bore phenomena.

Examples of Data from Test Rounds

HSTSS FPGA PCM Encoder Flight Test

Successful flight tests of an **HSTSS** miniature Field Programmable Gate Array (FPGA) Pulse Code Modulation (PCM) data encoder were conducted in late August. The FPGA PCM Encoder provided in-bore and in-flight data for a modified tank training round that was launched from a 120mm smooth bore cannon with a setback of 32,000g's and an exit muzzle velocity of 1080m/s. The on-board signal sources provided valuable ballistic timing and body-fixed inertial measurements.

The electronics board was designed and manufactured at **Naval Air Warfare Center (NAWC)** by **Gary Borgen**. The final design incorporated 4 channels of signal conditioning, 8-bit analog-to-digital conversion, and power source regulation. The **Advanced Munitions Concept Branch (AMCB) at the Army Research Laboratory (ARL)** integrated the board into a NATO-compatible fuze volume fitted with ARL-patented optical sensors, a MEMS accelerometer, an HSTSS LiMnO2 primary battery, and an L3 Communications transmitter-antenna package.

Flight test data and hardware were recovered from the test firing and were displayed at the **HSTSS** Symposium in Dallas and the Military and Aerospace Programmable Logic Devices (MAPLD) Conference held Sept. 28-30 at the **Johns Hopkins University Applied Physics Laboratory**. The Navy Best Buy Program will use five of the fuze packages for gun-launched two-stage rocket tests at Wallops Island, VA beginning December 1999.
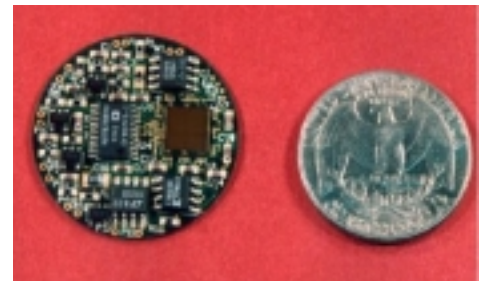

ARL modified hardware:
Entire instrumentation package contained within
a NATO-compatible fuze volume

ARL G-Hardedened Solar
Sensor

Ultralife Primary Battery

HSTSS FPGA PCM Encoder

HSTSS/MLRS Update

HSTSS/MLRS IPT members are completing prototypes of he **HSTSS**/**MLRS** telemeter set. Shock and Vibration testing of an assembled TM set is scheduled for early November. Flight test of five prototypes is scheduled for mid December or January.

Telemetry Set Details
- Telemetry Kit to fit in area between aft end of Fuze and the Forward Bulkhead
- 8 Channel, 8-B/W minimum Encoder
- 400 mW Transmitter
- Two Minute Minimum Battery Life
- Size and Shape allows for Installation of Kit without removal of Rocket from Launch Pod
- Antenna: Two Designs - Patch and Wrap Around

Transmitter Specifics
Emhiser Research Digital Transmitter
- Carrier Frequency: Frequency Selectable S Band
- Power: 400 mW
- Bit Rate: 1Kbs to 1.5 Mbs
- Input Voltage: 10.5 V to 16.5 V
- Input Current: 400 mA Max
- Dimensions: 1.25" W x 3.4" L x 0.3" H

(Will be replaced with M/A-COM Transmitter when available)

Encoder Specifics
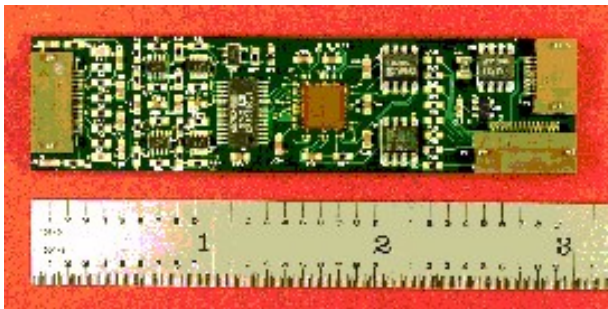FPGA PCM Encoder designed and built by Point Mugu
Interfaces directly to M445 Fuze
- Channels: 8
- Bit Rate: 240 Kbs
- Sample Rate: 2 kHz to 10 kHz
- Signal Range: DC - 0 to -37 V, AC - O to 25 V
- Modulation Output: RNRZ-L PCM

(Will be replaced by SPEC PCM DAC when available)

Battery Specifics
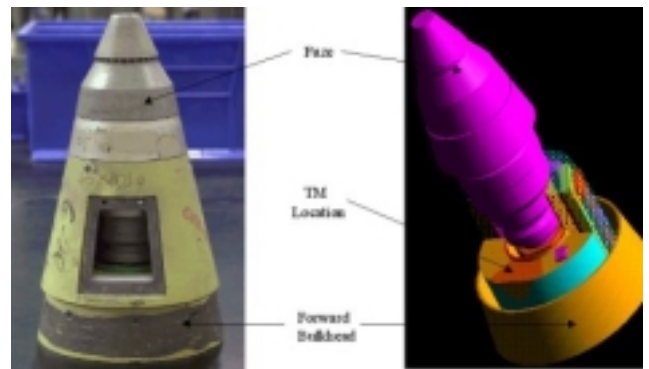Li/MnO$_2$ 'Thin Cell' Primary Battery
Developed by Ultralife Batteries
- Voltage: 11.5 V minimum
- Current: 500 mA minimum
- Duration: 2 minute minimum
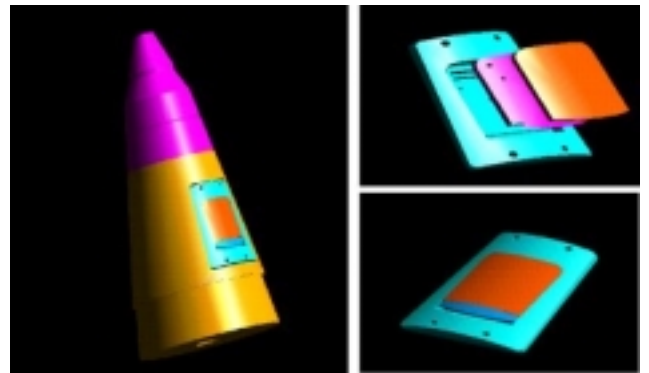- Dimensions: 1.2" W x 3.4" L x 0.4" H

MLRS Rocket in Launcher

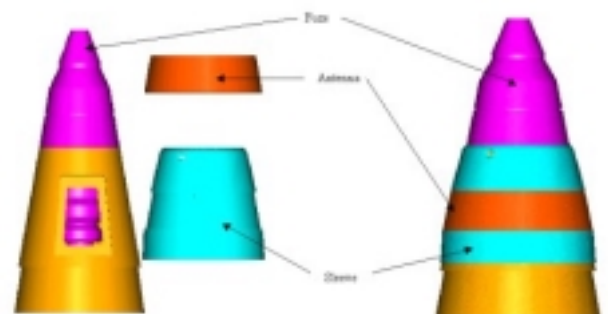Telemetry Set Location

Patch Antenna

HSTSS/**MLRS** FPGA PCM Encoder

Wrap-Around Antenna

HSTSS Presentation Agenda for ITC

Session 1
Chair: Martin Phillips, US Army STRICOM
2:00 PM, Wednesday, October 27
CAPRI 116

2:00 PM "**Program Management for 2001 Instrumentation**," Ronald Colangelo, HSTSS Project Director, US Army Simulation, Training, and Instrumentation Command

2:30 PM "**HSTSS Battery Development for Missile & Ballistic Telemetry Applications**," Lawrence W. Burke, and Edward Bukowski, US Army Research Laboratory, Colin Newnham and Neil Scholey, Ultralife Batteries (UK) Ltd., William Hoge and Zhiyaun Ye, Ultralife Batteries, Inc. (US)

3:00 PM "**Customizable Multichip Modules for High-G Telemetry Applications**," Peter Muller and Lawrence W. Burke, US Army Research Laboratory, Scott Sommerfeldt and Brent Lunceford, Microelectronics and Computer Technology Corporation (MCC), Shaun Francomacaro and S. John Lehtonen, Johns Hopkins University

3:30 PM "**A Telemetry Transmitter Chip Set for Ballistic Applications**," John Lachapelle, Finbarr McGrath, Karina Osgood, Bob Egri, Andy Moysenko, and Greg Henderson, M/A-COM Corporation, Lawrence W. Burke and Jonah N. Faust, US Army Research Laboratory

4:00 PM "**Combining Sensors with Airborne Telemetry Instrumentation to Make Range Measurements and Obtain Aerodynamics**," Bradford S. Davis and T. Gordon Brown, US Army Research Laboratory

4:30 PM "**Leveraging Government and Commercial Investments**," William P. D'Amico, US Army Research Laboratory

Session 2
Chair: Ron Colangelo, US Army STRICOM
8:30 AM, Thursday, October 28
CAPRI 116

8:30 AM "**A Modular Approach to Hardened Subminiature Telemetry and Sensor System (HSTSS) Development**," Robert E. Carpenter, Advanced Systems Technology, Inc. and Dennis Schneider, US Army Simulation, Training, and Instrumentation Command

9:00 AM "**The Application of Hardened Crystal Reference Oscillators into the Hardened Subminiature Telemetry and Sensor System (HSTSS) Program**," Alan D. Hart, US Army Yuma Proving Ground

9:30 AM "**HSTSS-DAC Custom Integrated Circuits for Subminiature PCM Telemetry and Signal Conditioning**," David Gibson, Dr. N. B. Penrose, and Michael Doerr, Systems & Processes Engineering Corporation (SPEC)

10:00 AM "**Digital FDM for the HSTSS DAC Program**," Michael B. Doerr, Dr. William H. Hallidy, Jr., Dr. Gary B. McMillian, Systems & Processes Engineering Corporation, Lawrence W. Burke, Jr. and Jonah N. Faust, US Army Research Laboratory

10:30 AM "**HSTSS-DAC Custom ICs Impact on 2.75" Missile Telemetry**," David A. Gibson and Newton B. Penrose, Systems & Processes Engineering Corporation and Ralph B. Wade, Jr., Air Force Development Test Center

11:00 AM "**Instrumentation and Logistics: Influencing Design and Ownership Costs**," Martin Phillips, US Army Simulation, Training and Instrumentation Command